MISTING APPARATUS WITH MOISTURE ELIMINATOR AND RELATED METHOD

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] There are many situations where it is desired to provide evaporative cooling in an area, or of people or other living beings (such as plants or animals) within the area. For that purpose, low pressure (under 100 psi), medium pressure (100 but under 200 psi), and high pressure (200+ psi) systems are commercially available. However, most such systems, while providing effective cooling, also add humidity to the air which in some cases is undesirable. Examples of current misting systems may be found in U.S. Patent Nos. 5,628,273; 6,175,969 and 6,262,826. These systems are utilized in a marine environment and provide for evaporative cooling associated with watercraft. In some applications, however, it is desirable that the cooled air not have the higher humidity level generated by the use of misting nozzles that add water droplets to the air.

[0002] According to the present invention, a compact misting apparatus or unit, usable with or without additional ducting, not only creates a high pressure mist to reduce the temperature of air flowing through the unit, but also eliminates a significant portion of the moisture before the cooled air exits the unit. In an exemplary embodiment, the misting apparatus includes a housing having top and bottom walls, a pair of side walls and a pair of end wall assemblies that, together, define an interior plenum chamber. A fan and associated misting nozzles are mounted in one of the end wall assemblies and

a moisture eliminator is mounted in the opposite end wall assembly such that air is drawn into the plenum chamber by the fan and cooled by the mist introduced by the misting nozzles (via latent heat of evaporation). As the cooled air flows through the moisture eliminator, unevaporated droplets are removed before the air flows into the space or area to be cooled.

[0003] At least one and preferably a plurality of misting nozzles are mounted in the center hub of the fan, at the outlet or downstream side of the fan, so that air flowing into the plenum chamber entrains the droplets of water emitted as a fine mist via the one or more nozzles.

[0004] The moisture eliminator in the opposite end wall assembly may comprise a plurality of generally vertically oriented vanes provided with individual profiles that are specially shaped to turn the air flow as it passes over and through the profiled surfaces. Since the unevaporated water have a higher mass than the air, the unevaporated droplets will impinge on the vane surfaces, forming a liquid film that is pushed along the vane surfaces into areas of low pressure located behind respective hook structures formed on the vanes. Here, the liquid film coalesces into larger droplets that drain via gravity onto the bottom wall of the plenum chamber. A drain in the bottom wall returns the water to a sump from which the water is recirculated to the misting nozzles.

[0005] A suitable pump supplies water at high pressure (typically between about 200 and 1000 psi) to the misting nozzles that are designed to emit droplets having a

maximum cross sectional dimension of between about 5 and 100 microns.

[0006] Accordingly, in one aspect, the present invention relates to a misting apparatus comprising a housing defined by a bottom wall, a top wall, a pair of side walls and a pair of end wall assemblies; a plenum chamber within the housing; a fan mounted in one of the end wall assemblies for supplying air flow to the plenum chamber; at least one misting nozzle located proximate to an outlet side of the fan to thereby supply droplets of water into the air flow, the at least one misting nozzle connected to a source of water under pressure; and a moisture eliminator mounted in the other of the end wall assemblies, the moisture eliminator shaped to remove unevaporated droplets before the air flow exits the plenum chamber.

[0007] In another aspect, the present invention relates to a method of supplying cooled air to a space comprising a) adding water droplets to a flow of air to thereby generate a flow of cooled air; b) removing unevaporated water droplets from the cooled air; and c) delivering the cooled air to the space.

[0008] In still another aspect, the invention relates to a method of cooling an area comprising a) introducing water droplets having a size of from 5-100 microns into an airflow entering a plenum chamber to thereby cool the airflow; b) removing unevaporated water droplets from the airflow as the airflow exits the plenum chamber; and c) supplying cooled airflow to the area.

[0009] The invention will now be described in connection with the drawings identified below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIGURE 1 is a perspective view, partially cut away, illustrating a compact mating apparatus for cooling an area, with an integrated moisture eliminator in accordance with an exemplary embodiment of the invention;

[0011] FIGURE 2 is a cross-section of a misting nozzle appropriate for use with the apparatus illustrated in Figure 1;

[0012] FIGURE 3 is a partial perspective view of one application for the apparatus shown in Figure 1; and

[0013] FIGURE 4 is a schematic view of an apparatus as shown in Figure 1 with ducting added between the apparatus and a remote outlet for the cooled air.

DETAILED DESCRIPTION OF THE INVENTION

[0014] With reference to Figures 1-3, the misting apparatus 10 in accordance with an exemplary embodiment of the invention includes a box-like housing 12 that is made up of a bottom wall 14, a top wall 16, a pair of side walls 18 and 20, and a pair of end wall assemblies 22 and 24. The end wall assembly 22 includes axially spaced wall sections 26 and 28 between which is mounted a fan 30. The assembly is secured to the housing top, bottom and side walls by any conventional means. The fan itself may be any suitable commercially available fan, for example, an 8 inch "Whisper Quiet Axial Marine Fan"

available from Delta "T" Systems, Inc. of Jupiter, Florida. This fan generates flows to 607 CFM and is secured within its own flanged housing 32 of cast aluminum that is secured by any suitable means, such as bolts, to the axially spaced wall sections 26 and 28, thus creating the end wall assembly 22. The fan 30 includes a center hub 34 to which is secured a nozzle assembly 36 that, in the exemplary embodiment, includes a plurality of misting nozzles that may be of the type sold by Fogco Systems, Ltd., of New Castle-on-Tyne, U.K., and that are preferably constructed of brass or steel. Each individual nozzle 38 may include one or more nozzle orifices 39 (not drawn to scale), each having a diameter of between about 0.2-0.5 mm. When supplied with water at a pressure of between about 200-1000 psi, the orifice(s) 39 of the nozzles 38 deliver a mist of water droplets having a maximum cross sectional dimension of between about 5-100 microns. This provides maximum flash evaporative cooling (the latent heat of evaporation of water is about 600 calories/gm), to reduce the temperature of the airflow in the plenum chamber by about 12-15°F.

[0015] Water is supplied to the misting nozzles 38 by means of a tube or conduit 40 that is connected to a pump (not shown). The pump per se is not part of this invention, and any suitable pump or other device for pressurizing liquid to a pressure of about 200 to 1000 psi may be utilized. For example, one suitable pressurizing pump is a Triplex Direct Drive Plunger Pump Model 2SF sold by Cat Pumps of Minneapolis, Minnesota. The mist emitted from the nozzles 38 is entrained into the airflow exiting the fan 30 in the direction of the

flow arrow in Figure 1 in a direction from the end wall assembly 22 (the inlet end) towards the end wall assembly 24 (or outlet end). Thus, the mist laden air flows through a plenum chamber 42 within the housing 12 toward the end wall assembly 24. End wall assembly 24 is also comprised of axially spaced wall sections 44, 46 that form a frame component for the moisture eliminator assembly 48. This assembly is also secured to the top, bottom and side walls by any conventional means, and comprises a plurality of generally vertically oriented vanes 50 that are each formed with a curved profile so that air flowing in the flow direction is caused to turn as it flows between the vanes.

[0016] Each vane 50 is formed with an integral hook portion 52 that creates a low pressure area 54 along the vertical length of the vanes. In operation, since the unevaporated mist or moisture droplets have a higher mass than air, they cannot change direction as quickly as air and, as the air flows through the vanes 50, the moisture droplets impinge upon the surfaces of the vanes 50, forming a liquid film that is driven by the air flow into the low pressure areas 54 between the hook portions 52 and vanes 50. As water collects in these low pressure areas, it will coalesce and form droplets that drain by gravity through one or more slots 54 in the wall section 44, onto the bottom wall 14 of the housing. The water will then flow through a drain 56 to a sump (not shown) from which water will be recycled to the misting nozzles 38 on the hub 34 of the fan 30.

[0017] It will be appreciated that the apparatus as described may be located behind the wall of an interior

space, with the end wall assembly 24 and moisture eliminator 48 located flush with the wall surface so that cooled relatively dry air will flow into the area where cooling is desired. One such example is shown in Figure 3 where the apparatus 10 is mounted behind an exterior wall 58, with the end wall assembly 24 substantially flush with the outside surface of the wall 58, such that cooled air is supplied to a patio or outside eating area 60 of, for example, a restaurant. Of course, the site location of the unit may be varied as desired.

[0018] Figure 4 illustrates, schematically, another embodiment where a misting unit 62 similar to unit 10 in Figure 1, is located remote from a cool air supply vent or grill 64 mounted on a vertical wall 66, with ducting 68 extending between the unit 62 and vent 64. It will be understood that the moisture eliminator may be integrated with the unit 64 similar to the arrangement in Figure 1, or it may be incorporated into the vent 64.

[0019] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.